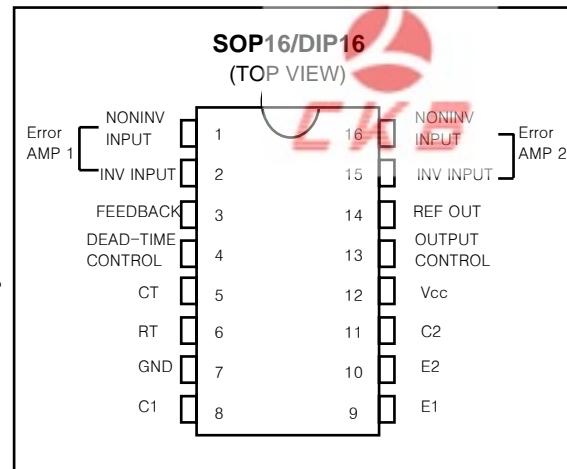


# Pulse-Width-Modulation Control Circuits

TL494

## FEATURES

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200 Ma Sink or Source Current
- Output Control Selects Single-Ended or Push-Pull Operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Variable Dead-Time Provides Control over Total Range
- Internal Regulator Provides a Stable 5-V Reference Supply, 5%
- Circuit Architecture Allows Easy Synchronization
- Moisture Sensitivity Level 3



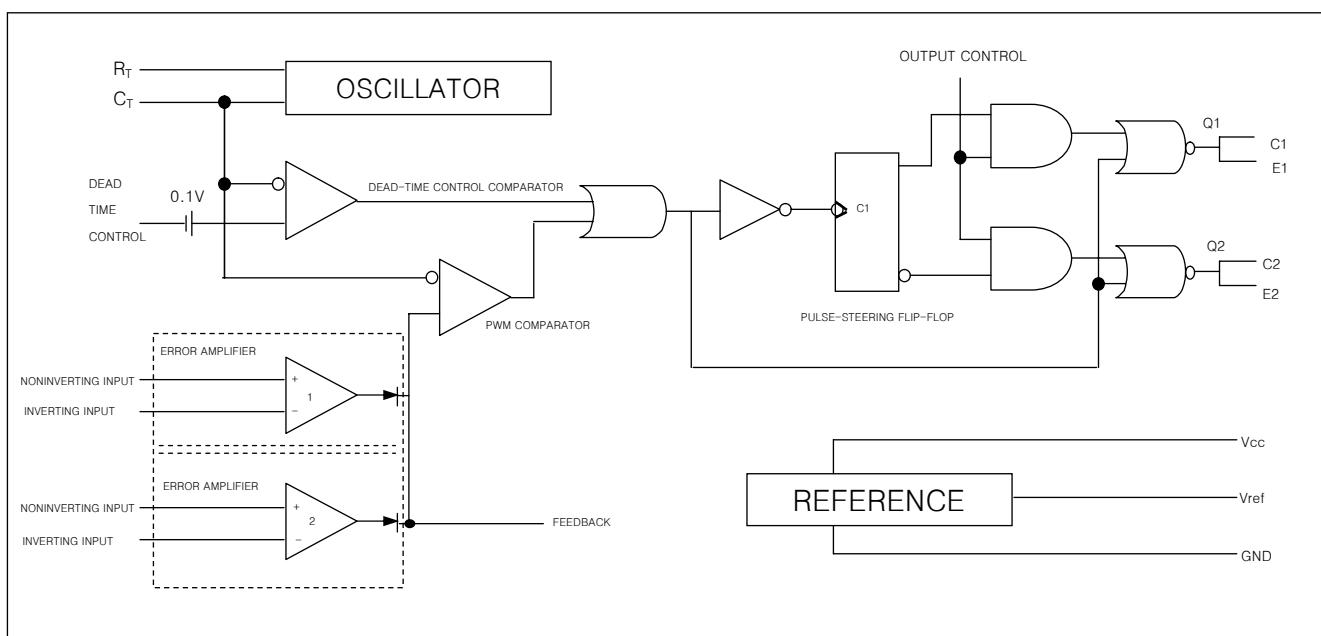
## DESCRIPTION

The TL494 incorporate on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control, these devices offer the systems engineer the flexibility to tailor the power supply control circuitry to his application.

The TL494 contains an error amplifier, an on-chip adjustable oscillator, a dead-time control comparator, pulse-steering control flip-flop, a 5-volt, 5% precision regulator, and output-control circuit.

The error amplifier exhibits a common-mode voltage range from -0.3 volts to Vcc - 2 volts. The dead-time control comparator has a fixed offset that provides approximately 5% dead time when externally altered. The on-chip oscillator may be bypassed by terminating R<sub>T</sub> (pin 6) to the reference output and providing a sawtooth input to CT (pin 5), or it may be used to drive the common circuits in synchronous multiple-rail power supplies. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Each Device provides for push-pull or single-ended output operation, which may be selected through the output-control function. The architecture of these devices prohibits the possibility of either output being pulsed twice during push-pull operation.

## Functional Block Diagram



Parameter measurement information

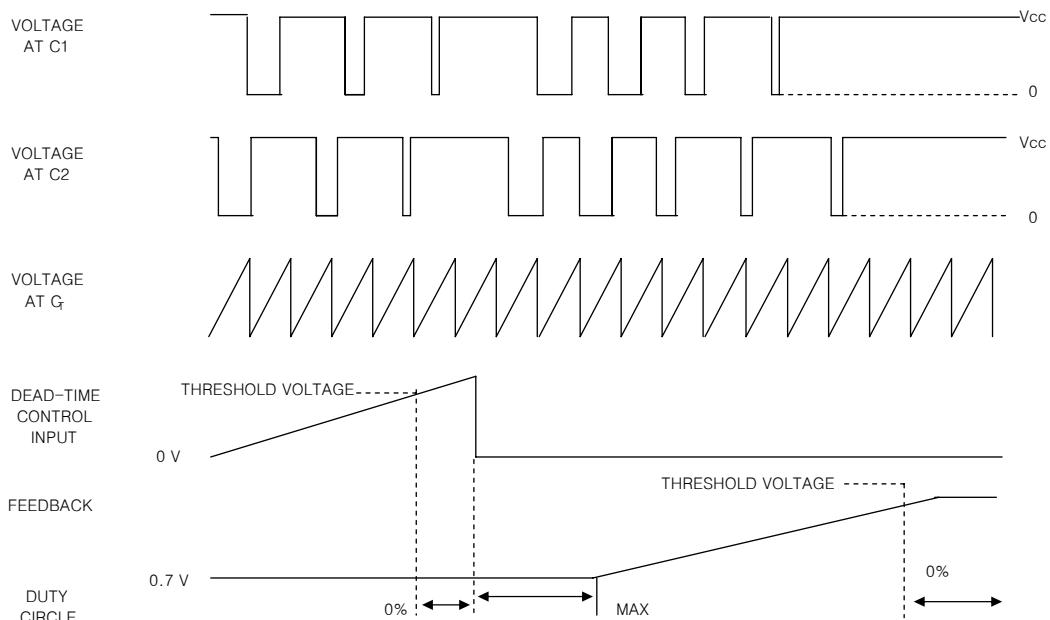
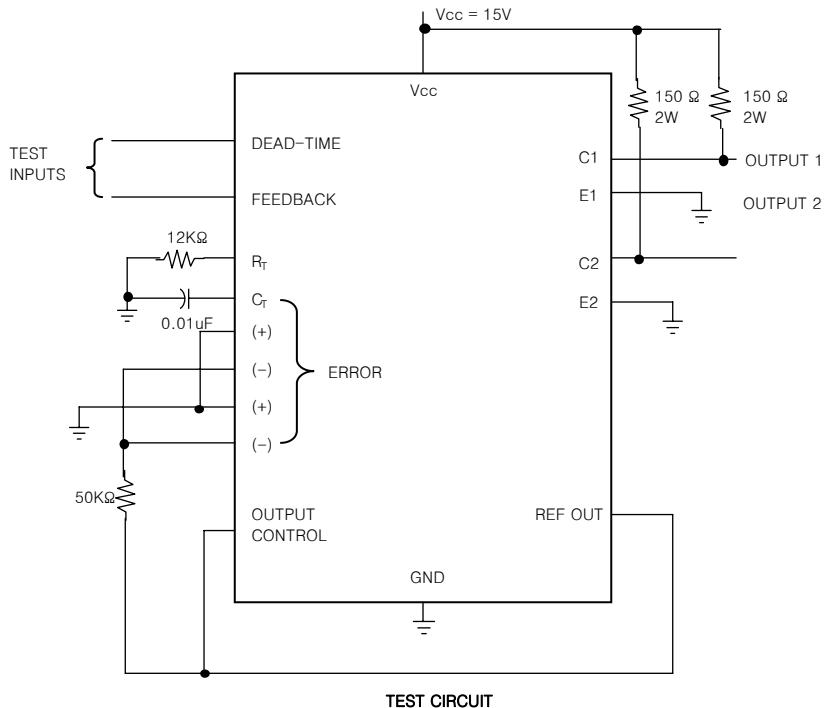


Figure 1. OPERATIONAL TEST CIRCUIT AND WAVEFORMS

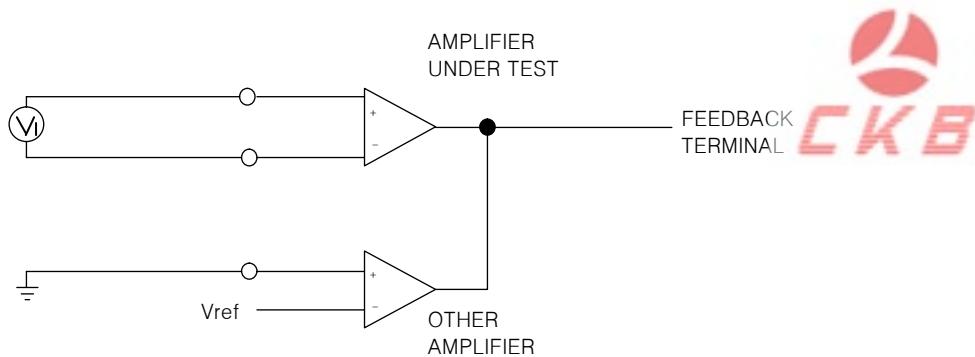


FIGURE 2. AMPLIFIER CHARACTERISTICS

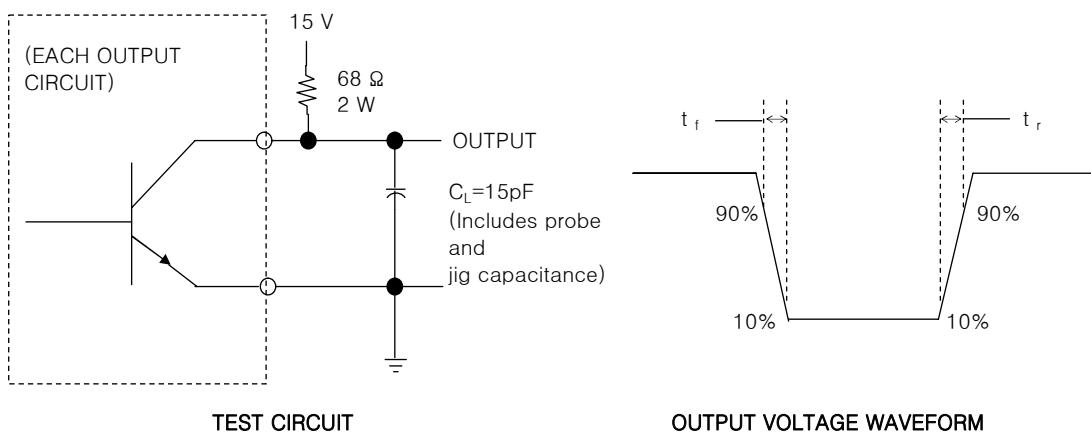


FIGURE 3. COMMON-EMITTER CONFIGURATION

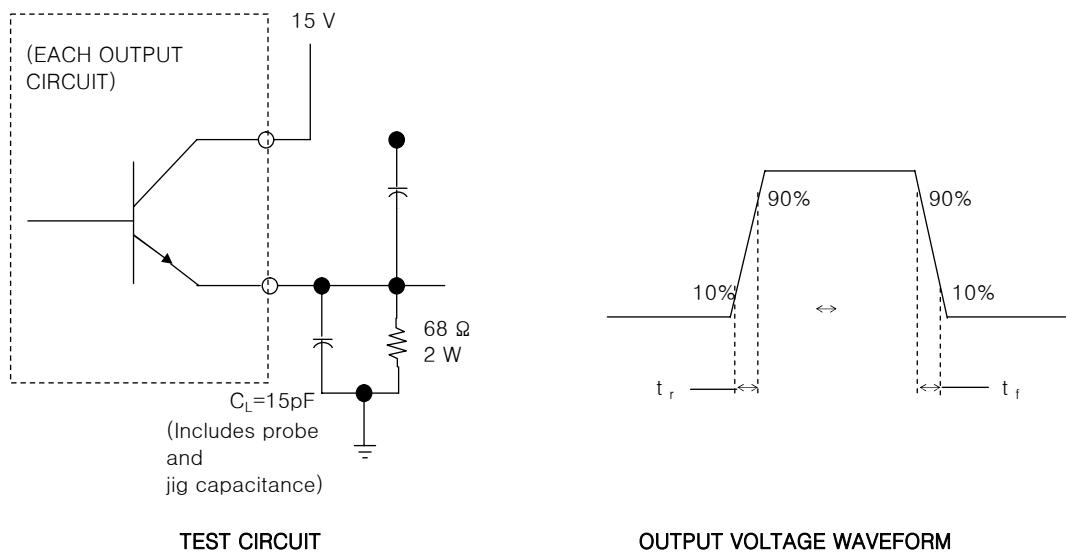


FIGURE 4. Emitter-Follower Configuration

# Pulse-Width-Modulation Control Circuits

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## ABSOLUTE MAXIMUM RATINGS OVER OPERATING FREE-AIR TEMPERATURE RANGE



Rating	Value	Unit
Supply voltage, Vcc	41	V
Amplifier input voltage	Vcc +0.3	
Collector output voltage	41	
Collector output current	250	
Operating free-air temperature range	0 to 70	
Storage temperature range	-65 to 150	
Lead temperature 1,6 mm from case for 10 seconds	260	°C

## RECOMMENDED OPERATING CONDITIONS

Parameter	Value		Unit
	MIN	MAX	
Supply voltage, Vcc	7	40	V
Amplifier input voltage, Vi	-0.3	Vcc -2	
Collector output voltage, Vo		40	
Collector output current (each transistor)		200	
Current into feedback terminal		0.3	
Timing capacitor, C <sub>T</sub>	0.47	10000	nF
Timing resistor, R <sub>T</sub>	1.8	500	kΩ
Oscillator frequency	1	300	kHz
Operating free-air temperature, T <sub>A</sub>	0	70	°C

Electrical characteristics over recommended operating free-air temperature range,

Vcc=15V, f= 10 kHz(unless otherwise noted).

Parameter	Test Conditions*	Value			Unit
		MIN	TYP**	MAX	
Output voltage (Vref)	I <sub>O</sub> = 1mA	4.75	5	5.25	V
Input regulation	Vcc = 7V to 40 V		2	25	mV
Output regulation	I <sub>O</sub> = 1mA to 10mA		1	15	
Output voltage change with temperature	T <sub>A</sub> = MIN to MAX		0.2	1	%
Short-circuit output current***	Vref = 0		35		mA

## Oscillator section (See Figure 1)

Parameter	Test Conditions*	Value			Unit	
		MIN	TYP**	MAX		
Frequency	C <sub>T</sub> =0.01μF, R <sub>T</sub> =12kΩ		10		kHz	
Standard deviation of frequency****	All values of Vcc, C <sub>T</sub> , R <sub>T</sub> ,		10		%	
	and T <sub>A</sub> constant					
Frequency change with voltage	Vcc=7V to 40V, T <sub>A</sub> =25°C		0.1			
Frequency change with temperature****	C <sub>T</sub> =0.01μF, R <sub>T</sub> =12kΩ,			1		
	T <sub>A</sub> = MIN to MAX					

# Pulse-Width-Modulation Control Circuits

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Electrical characteristics over recommended operating free-air temperature range,  
 $V_{CC}=15V$ ,  $f=10kHz$  (unless otherwise noted)



## Amplifier section (See Figure 2)

SYMBOL	TEST CONDITIONS	MIN.	TYP**.	MAX.	UNIT
Input offset voltage	$V_o(\text{pin 3})=2.5V$		2	10	mV
Input offset current	$V_o(\text{pin 3})=2.5V$		25	250	nA
Input bias current	$V_o(\text{pin 3})=2.5V$		0.2	1	$\mu A$
Common-mode input voltage range	$V_{CC}=7V$ to $40V$	-0.3~-2			V
Open-loop voltage amplification	$V_o=3V$ , $R_L=2K\Omega$ , $V_o=0.5\sim3.5V$	70	95		dB
Unity-gain bandwidth	$V_o=0.5\sim3.5V$ , $R_L=2K\Omega$		800		kHz
Common-mode rejection ratio	$V_o=40V$ , $T_A=25^\circ C$	65	80		dB
Output sink current (pin 3)	$V_{ID}=-15mV\sim-5V$ , $V_o(\text{pin 3})=0.7V$	0.3	0.7		mA
Output source current (pin 3)	$V_{ID}=15mV\sim5V$ , $V_o(\text{pin 3})=3.5V$	-2			mA

\*For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

\*\* All typical values except for parameter changes with temperature are at  $T_A=25^\circ C$

\*\*\* Duration of the short-circuit should not exceed one second.

\*\*\*\* Standard deviation is a measure of the statistical distribution about the mean as derived from the formula.

\*\*\*\*\* Temperature coefficient of timing capacitor and timing resistor not taken into account.

## Output section

PARAMETER	TEST CONDITIONS	MIN.	TYP*	MAX.	UNIT
Collector off-state current	$V_{CE}=40V$ , $V_{CC}=40V$		2	100	$\mu A$
	$V_{CC}=V_C=40V$ , $V_E=0$			-100	
Collector-emitter saturation voltage	$V_E=0$ , $I_C=200mA$		1.1	1.3	V
	$V_C=15V$ , $I_E=-200mA$		1.5	2.5	
Output control input current	$V_I=V_{ref}$			3.5	mA

## Dead-time control-section (See Figure 1)

PARAMETER	TEST CONDITIONS	MIN.	TYP*	MAX.	UNIT
Input bias current(pin4)	$V_I=0$ to $5.25V$		-2	-10	$\mu A$
	$V_I(\text{pin 4})=0$ , $C_T=0.1\mu F$ , $R_T=12K\Omega$		45		
Input threshold voltage(pin 4)	Zero duty cycle		3	3.3	V
	Maximum duty cycle	0			

## PMW comparator section (See Figure 1)

PARAMETER	TEST CONDITIONS	MIN.	TYP*	MAX.	UNIT
Input threshold voltage (pin3)	Zero duty cycle		4	4.5	V
Input sink current (pin 3)	$V_o(\text{pin 3})=0.7V$	0.3	0.7		mA

## Total device

PARAMETER	TEST CONDITIONS	MIN.	TYP*	MAX.	UNIT
Standby supply current	Pin 6 at $V_{ref}$ , all other inputs and outputs open	$V_{CC}=15V$	6	10	mA
		$V_{CC}=40V$	9	15	
Average supply current	$V_I(\text{pin 4})=2V$		7.5		

# Pulse-Width-Modulation Control Circuits

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Switching characteristics,  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN.	TYP*	MAX.	UNIT
Output voltage rise time	Common-emitter configuration		100	200	ns
Output voltage fall time			25	100	
Output voltage rise time	Emitter-follower configuration		100	200	
Output voltage fall time			40	100	

\* All typical values except for temperature coefficient are at  $T_A = 25^\circ\text{C}$

